V. Renard (vrenard@adtech2.oceaneering.com; 509-946-5170)
Oceaneering Hanford
660 Swift Boulevard, Suite D
Richland, Washington 99352

REMOTE OPERATED VEHICLE, DRY ICE PELLET DECONTAMINATION SYSTEM

Contract number DE-AC21-93MC30165
Mr. Ron Staubly, FETC COR
Period of Performance September 24, 1993 to January 15, 1998

Introduction/Needs

ROVCO_2 was developed under a Department of Energy (DOE) program at the Federal Energy Technology Center (formerly METC) in response to a need at the Oak Ridge K-25 site, and other sites, for concrete floor decontamination. The development program has been contracted in three phases. In Phase 1, critical subsystems including carbon dioxide blasting, the vehicle, manipulation, and controls were developed, integrated, and tested. In Phase 2, the vacuum, filtration, and containment subsystems were integrated and the system itself tested for productivity, reliability, and effectiveness. In Phase 3, the entire system will be tested in a mocked-up test environment at Florida International University.

The success of the development plan will assure the success of the Robotics Technology Development Program by meeting the goals in its mission. Specifically, the ROVCO_2 satisfies the D&D goal for teleoperated systems for D&D of retired facilities by successfully decontaminating permeable concrete surfaces, containing the contaminates, and restoring the facility to use while maintaining operator safety and health.

Oceaneering's commitment to the DOE decontamination effort has grown since the start of ROVCO_2. During Phase 3 of the program ROVCO_2 was transferred to Oceaneering Hanford in Richland, Washington, a division providing remote operation support on the Hanford Site. The transition to the Hanford Site will reduce site training costs with the use of trained personnel and provide continued support for site demonstrations and D&D work.

Objectives/Problem

The objectives of the ROVCO_2 program are as follows:

- reduction in waste volume,
- faster decontamination of floors,
- improved decontamination effectiveness,
- reduced decontamination costs, and
- reduction in worker exposure to contaminants.

Phase 3 - Integrated System Testing - the current phase of operations is tasked with the following objectives:

- ROVCO_2 shall clean the concrete test surface to free release levels achieving a decontamination factor of 5 or greater,
- ROVCO_2 shall improve worker productivity through automation of tedious repetitive tasks, and
- Reducing decontamination costs by reducing worker exposure to contaminants, reducing the number of people required, reducing plant down time by 20% or more, and elimination of blasting retreatment due to gaps in the coverage.

Approach/Solution

To meet these objectives Oceaneering redesigned the workhead. With the aid of a deflector plate, the blast flow momentum is redirected upward towards the high vacuum section of the workhead. This accomplished while maintaining the lower section of the workhead pressed tightly against the floor at all times. An adjustable deflector plate was designed that incorporates a nylon pad. The workhead rides on this nylon pad sealing the blasting area while reducing drag and minimizing the loads on the COYOTEE.

Oceaneering will conduct verification tests for Phase 3 to verify effectiveness, reliability, and productivity of ROVCO$_2$ by building on the Phase 2 operational experience.

Project Description/Technology

The Remote Operated Vehicle with Carbon Dioxide Blasting (ROVCO$_2$) is a six wheeled remote land vehicle used to decontaminate concrete floors. The remote vehicle has a high pressure Cryogenesis blasting subsystem, which performs the actual decontamination work and consists of the dry ice supply unit, the blasting nozzle, the remotely controlled electric and pneumatic valves, and the vacuum workhead. Also developed was a CO_2 xY Orthogonal Translational End Effector (COYOTEE) subsystem and a vacuum/filtration and containment subsystem. The COYOTEE subsystem positions the blasting workhead within a planar work space and the vacuum subsystem provides filtration and containment of the debris generated by the CO_2 blasting. This subsystem employs a High Efficiency Particulate Air (HEPA) filtration unit to separate contaminants for disposal. This subsystems are all attached to the vehicle subsystem via a support structure.

Two camera/light assemblies, one black and white fixed-position camera and one color camera mounted on a pant and tilt unit provide viewing for navigation, obstacle avoidance, and operations.

Separate from the vehicle are the tether management subsystem and the operator control unit. The tether management system provides an electric winch to manage the vehicle's 300 foot umbilical. The umbilical provides command, data, and power transfer between the vehicle and the control subsystem. Additionally, it provides a delivery system for the compressed gas that is used in the blasting system. The operator control unit provides a single operator, integrated controls, automated repetitive functions, video display, and equipment status feedback.

Results/Accomplishments

As reported at previous FETC conferences, in Phase 1 Oceaneering met or exceeded all success criteria during the concept demonstration including mobility of the vehicle, maneuverability of the workhead, effective control of all functions of the operator control unit, and effective operation of the blasting nozzle. During Phase 2 all fabrication and design work proposed was accomplished including additions of the vacuum/filtration/containment subsystem, addition of the tether management subsystem, and modifications and enhancements to the ROVCO$_2$ system from Phase 1.

ROVCO$_2$ Versus Other Technologies

The ROVCO$_2$ system compares quite favorably when compared to other methods used to decontaminate concrete. It is a difficult task to compare each technology due to the number of factors involved with each system. Table1 was created by altering the ROVCO$_2$ evaluation to meet the others, resulting in an attempt to standardize the comparison of the technologies. The end notes describe the conditions and assumptions used. Sources for the information included O'Brien & Gere Engineers, Inc., and LTC, manufaturers of the soda blasting and vacuum blasting technologies, respectively.

Table 1: Economic comparison of $ROVCO_2$ vs. Similar Technologies

Technology	**$ROVCO_2$**	**7" Shot Blasting**	**Soda Blaster**
Production Rate	10 to 120 sf/hr[1]	NA	120 to 240 sf/hr[2]
Depth of Penetration	0.014"[2]	0.03125"	<0.03125"
Solid Waste Generation[3]	0.0012 cf/sf	0.0026cf/sf	0.007 cf/sf
Liquid Waste Generation	None	None	1.9 gal/sf
Disposal Unit Cost[4]	$0.16/sf	$0.35/sf	$1.14/sf
Removal Unit Costs	$0.68/sf[5]	$2.18/sf	$5.62/sf[6]
Total Unit Costs for Removal and Disposal	$0.84/sf	$2.53/sf	$6.76/sf
Estimated Capital Costs	$457K	$4M	$30-35K

Notes

1. Production rate depends on level of contamination and coating type.
2. Based on removing epoxy at 3 mil thick, and >1 mil concrete removal.
3. Included concrete volume (based on maximum depth of removal indicated) plus 20 percent volume expansion factor.
4. Disposal costs estimated to be $1000/drum which is equivalent to $136/cf.
5. Based on productivity rate of 100 sf/hour (achievable rate for 98 percent removal of sealant) and labor rate including a one person team at $37/person/hour.
6. Based on a productivity rate of 120 sf/hour (achievable rate for removing light non-epoxy paints) and a labor rate including a two person team at $37/person/hour.

Application/Benefits

Oceaneering is working with DOE to establish an appropriate hot site for initial $ROVCO_2$ operations.

Future Activities

At the present time $ROVCO_2$ is preparing for verification testing at the Richland, Washington site and further testing at Florida International University.